Nerdy Bridge Engineer Facts:

Only a bridge engineer would dream about these technical facts.

- The bridge deck is conventional class 4000D cast-in-place concrete.
- The “A” dimension at center line of web at center line of Pier 1 and Pier 2 equals to 11.5”.
- The bridge approaches are conventional class 4000A concrete.
- The tub girders are the WSDOT U78PTG5 series.
- The tub girders concrete strength at 28 days is 8.5 ksi.
- Elastomeric bearing pads were installed at each Pier.
- The shallow foundation consists of conventional cast in place concrete 18’-0” high.
- Concrete seals were required both at Pier 1 and Pier 2.
- The bridge construction cost was $2.49 million.

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US 97 Satus Creek Bridge Replacement Project

Crossing an Environmentally Sensitive Creek

The Satus Creek Bridge represents an entirely new innovation in bridge design. It is a curved prefabricated concrete bridge. It was built in segments and then delivered to a remote site. The impressively long 180 foot single span was necessary to satisfy environmental constraints at the highway crossing of Satus Creek.

The bridge is located 25 miles southwest of Toppenish Washington along US 97. It was constructed as part of a $13.4 million project completed in the first part of 2013. It replaced an old, load restricted timber bridge built in 1942. This new and modern resilient structure corrects design deficiencies with the old timber bridge including vehicular impact and seismic resistance. Several unique features are implemented in the design including horizontally curved and spliced prefabricated girder segments.

Bridge Facts Profile:

Bridge Structure Cost: $2.49 million

Owner: Washington State Department of Transportation

Bridge Designer Engineer: Michael Bressan, PE

State Bridge Architect: Paul D. Kinderman, PE, AIA

State Bridge Engineer: Bijan Khaleghi, PE, SE, PhD

General Contractor: Franklin Pacific Construction Company, Seattle, WA

Post-Tensioning Contractor: Schwager Davis Inc., San Jose, CA

Pre-caster: Concrete Technology Corporation, Tacoma, WA

Innovative Horizontally Curved Prefabricated Girders

The superstructure is built from open precast concrete box girders, referred to as “tubs” in bridge parlance. The new feature is horizontally curved girders, which are tipped to match a steep cross slope dictated by the local roadway geometric constraints. The tub girders are a variation on WSDOT’s popular U78PTG5 series. The ‘78’ indicates the height of the tub webs in inches and the ‘5’ identifies the width of the bottom flange in feet.

To achieve the long simple span across Satus Creek, each ‘girder line’ consists of three precast girder tub segments. Spliced sections, prefabricated miles away, were shipped to the site. Temporary towers were used to support the segments while the concrete bridge roadway deck was cast. Each vertical ‘web’ had three post-tensioning tendons for a total force of about 1,253 tons per web. That’s a lot of force. It’s the weight of a many, many cars. The tendons are a bit like those in the human body, they connect the bones of the bridge together.

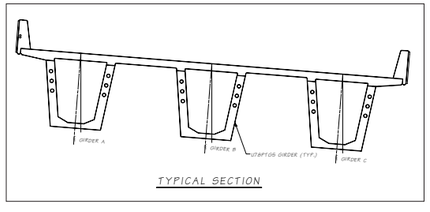
Constructing the Satus Creek Bridge: A Kit of Parts, WSDOT and Professional Institutes

After 1,253 tons of force was applied to the tendons the temporary work towers were removed. Splicing the segments on the job site made the kit of parts into a single structural unit. This construction technique gave WSDOT the ability to achieve longer bridge span. The construction method also eliminated the need for an intermediate pier in the environmentally sensitive waterway areas. This was a great cost savings and it satisfied the creeks environmental needs. Another added benefit that came with the spliced girders concept was reduced shipping costs. The segments were easier to transport and more shipping routes became available to the girder fabricator.

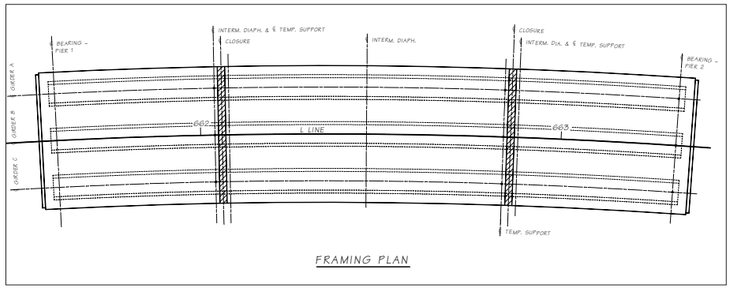
Each girder segment was precast with a 1,290 ft. radius in the horizontal plane. WSDOT contract documents

allowed the girder manufacturer to ‘chord’ the girder segments to achieve the prescribed radius. However for this particular project the girder manufacturer was able to build a form to the set radius achieving a smooth face for each girder segment and a smoother transition between segments at time of assembly.

WSDOT works closely with the Pacific Northwest Precast Concrete Institute to develop new technologies. WSDOT and the Institute members are national leaders with a keen interest in innovative technologies. They are part of a collegial professional engineering and bridge construction elite aimed at serving the public good.



TYPICAL SECTION



FRAMING PLAN

Engineers and Computers: WSDOT shares software

In this particular project the curved girders were analyzed by our engineers with complicated computer software, such as PG-Splice, PG-Super and Con-Splice. PG-Splice and PG-Super, were developed by WSDOT. Hundreds of calculations were checked to ensure the girders remained within allowable stresses during shipping, handling and final assembly of the girders. The computer software is currently used by states all over the nation. And it’s particularly helpful to smaller entities, like cities and counties. These local organizations have limited resources and count on WSDOT for its expertise.

The Satus Creek Bridge is the first horizontally curved precast post-tensioned girder bridge to be built in the State of Washington. It is a cost effective, durable and resilient structure that is aesthetically pleasing while satisfying the geometric and environmental constraints of the site. The Satus Creek Bridge was a testing ground for the WSDOT Bridge and Structures Office. The team did not encounter significant issues during the design or construction phases of this project. It was a great success!

Aesthetics: A beautiful setting

The bridge is located in a beautiful setting. And WSDOT’s professional bridge architects, landscape architects, environmental scientists and hydraulic engineers all worked together collaboratively. Using principles of the Federal Highway Administrations Context Sensitive Design they’ve blended the structure with its surroundings.

It’s located in the rural semi-arid region of south central Washington State. Except for the creek valley the area is treeless. Native grasses, sage brush and basalt rock create colors ranging from golden yellows to reddish browns. The bridge surfaces respond to these textures and colors. The abutments and retaining walls were cast in place with fractured basalt form-liners, while the finish was colored with a natural oxidizing agent to blend with the terrain. The barrier and girders were colored and textured for contrast.

The use of curved concrete girders transforms the aesthetic possibilities of precast bridges. Although straight girder sections can be placed on horizontal alignments, there are limits to deck overhangs. And these overhangs are invariably changing, creating visual discord. However, now with the use of curved girders, the horizontal radius can be less and the deck overhang remains constant.